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NOTES AND LITERATURE

RECENT CONTRIBUTIONS TO A KNOWLEDGE OF THE EXTINCT AMPHIBIA

THE past few months have witnessed an unusual activity among paleontologists in behalf of the extinct Amphibia. There have been several rather extensive papers and an important memoir on the group issued within the last twelve months. It is to be hoped that many other investigators will come to be interested in this group of vertebrates, for it is only by descriptions and discussions that we shall ever attain any adequate conception of the relationships of these highly interesting and important forms. The writer is of the opinion that the present conception is capable of considerable improvement and in order to facilitate this improvement he offers a review of the recent literature on the group.

Dr. A. Smith Woodward (1) has described an interesting new amphibian from the "Oil Shale, at Airly, New South Wales." Dr. Woodward locates his form in the genus *Bothriceps* of Huxley. The skull and greater part of the vertebral column with the ribs and a portion of the right arm are preserved. It is described as a new species under the name *Bothriceps major*, but as this term had already been used by Lydekker for the reception of the uncertain *Petrophryne major* of Owen¹ it will be necessary for the Australian specimen to receive a new name, for which the term *Bothriceps woodwardi* would not be inappropriate. Dr. Woodward allies the form with the Archegosauridæ, but the reviewer is rather inclined to think that the Tuditanidæ would be its nearer relatives. This is the third form described from the Hawkesbury formation of New South Wales. Further search will undoubtedly reveal other Paleozoic amphibia. It will be noticed in this as in so many other Paleozoic localities where fossil amphibia are found, that nearly every new specimen represents an unknown form, thus indicating the diversity and age of the group. The known species from the Hawkesbury formation are: *Bothriceps australis* Huxley, *Bothriceps woodwardi* and *Platyceps wilkinsoni* Stephens.

Dr. S. W. Williston has described in some detail (2) the

¹ Cat. Fossil Amphb. and Rept. Brit. Museum, Pt. IV, p. 174.

remains of *Dissorophus multicinctus* Cope which has recently been recovered from the reputed Permian of Texas. His material greatly increases our knowledge of the genus and of the anatomy of the Permian amphibia. He describes a complete skull, in which, unfortunately, the sutures are not discernible. Nor are the lateral line canals to be found, a fact to be regretted since we shall undoubtedly be enabled to base considerable importance on these structures did they occur. The skull roof is pitted like all other of the Permian amphibia from Texas. A large portion of the carapace is described with its attached vertebræ. The dermal shield is broad, continuous and pitted, forming a covering over the thoracic region of the animal. Limb bones, a scapula and a portion of the interclavicle are described. The form is closely related to another animal recently described by Dr. Williston and the two are placed in the new family Dissorophidæ. The paper closes with a taxonomic list of the Permian amphibia from Texas for which paleontologists will be grateful. There are three orders, nine families and thirty-four species so far known in the fauna.

The same writer has described (3) a nearly complete skeleton of a new temnospondylous amphibian from the Texas Permian. The form is very remarkable in several of its characters. The following are the chief unusual characters of the new genus: a median unpaired rostral opening leading into a palatine vacuity, greatly enlarged antorbital vacuities, temporal fenestræ, apparent absence of the parasphenoid bone, osseous carpus and tarsus and the possession of short heavy ribs borne on transverse processes. The skeleton is greatly similar to that of *Eryops*, but the skull shows decided differences.

The temporal fenestra is not homologous to the superior temporal fenestra of reptiles, but it is rather to be considered as a greatly elongate and closed epiotic notch. The median unpaired rostral opening is similar in structure to the one found in the skull of *Dasyceps bucklandi* Lloyd from the Permian of Kenilworth, though in the present form the opening is much further forward and smaller. The antorbital vacuities in the present form, on the other hand, are much larger than the same openings in *Dasyceps*.

Dr. Williston was able to make out the complete anatomy of the skull and has figured it in three views. The most remarkable feature of the palatal structure is the apparent absence of the parasphenoid. The vertebral formula is 22 for the presacral vertebræ, an uncertain number of caudals and a single sacral. The

sacral rib is much like that of *Eryops* in which the structure takes a very unusual form for a rib. The phalangeal formula for the foot is 1, 2, 3, 4, 2. The complete number of digits in the hand is not preserved. The carpus has nine possibly eleven osseous elements, and the tarsus has twelve osseous elements.

The paper is well illustrated. There is a restoration of the skeleton of *Trematops milleri* and an outline drawing of the scapula of *Eryops latus* Case. The new genus *Trematops* is the type of a new family Trematopsidae in which the form described by Cope as *Acheloma cumminsi* is doubtfully associated.

The same writer (4) has redescribed from more complete material the species named by Cope as *Diplocaulus limbatus* from the Permian of Texas. The paper is based on several more or less incomplete skeletons. These include several additional features to our knowledge of the anatomy of the peculiar Diplocaulidae. Limbs have heretofore been unknown in the group although their presence has been suspected from the presence of pectoral girdles preserved with some specimens. Dr. Williston, however, for the first time actually describes well-formed limb bones for the group. The humerus is very remarkable in that it has an epicondylar foramen, a character known in only one other amphibian, *Acheloma*. The complete morphology of the skull with the exception of some features of the palate are made out and represented in two plates. The clavicular girdle, mandible, vertebrae and limb bones are represented in other plates. The paper concludes with remarks concerning the relationship of the group to which *Diplocaulus* belongs and associates the Oklahoma Permian form *Crossotelos* with the *Diplocaulus*. He remarks that in the Microsauria the capitulum of the rib is always attached intercentrally and suggests that *Diplocaulus* must be retained among the Microsauria.

The same writer (5) has given an extensive paper on new Permian forms in which he describes a new genus and species of amphibia under the name *Cacops aspidephorus*. This form he locates in the family Dissorophidae. The paper opens with a brief discussion of the "Character of the Permian Beds of Northern Texas," "Conditions of Fossilization" and "Associated Vertebrates." The form described in the paper is represented by a skeleton which is remarkably complete "with no more plaster in its construction than was necessary to cement the freshly broken parts . . . save of many of the phalanges. . . ." It was so complete and well preserved as to be capable of being mounted like a recent skeleton which has been well executed by

Mr. Paul Miller with remarkable success. A photograph of the mounted skeleton is given in one of the plates.

There are four skulls. The most remarkable feature of the dorsum is the presence of a closed otic notch which resembles a temporal fenestra. In none of the skulls was it possible to determine the sutures and the structure of the skull had to be determined more by topographic features. The structure of the palate is of the stegocephalian type, though remarkable in some of its features, such as the large size of the palatal openings. The vertebræ were preserved practically complete and the vertebral formula is—presacral, 21; sacral, 2; pygals, 6, and chevron caudals, 15 or 16. Fifteen of the vertebral spines are elongated and expanded and serve to support a carapace of shield-shaped, scute-like plates which overlap shingle-like. They greatly resemble in structure the dermal plates of *Dissorophus*. A discussion of the "carapace in allied forms" is given and the dermal elements of *Aspidosaurus*, *Zatrachys*, *Dissorophus* are discussed. Plates are suggested by the expanded neural spines of *Euchiro-saurus* and *Eryops*.

The vertebral column is fully discussed. This includes some unusual features, such as two sacral vertebræ and a well-preserved atlas which is composed of a single piece. The writer discusses also the significance of the hypocentra and pleurocentra, one of the most perplexed questions in connection with the extinct amphibia. The pectoral girdle consists of the fused scapula-coracoid, a cleithrum, clavicles and interclavicle. The humerus and its use in diagnosis is discussed at some length. Among the material studied are many humeri, some of which suggest unknown forms of amphibia. Two new families, the Trematopsidæ and Dissorophidæ, are proposed and the characters given. The paper closes with a discussion of the restoration of *Cacops* and the description of a peculiar form of reptile in which the vertebræ are intermediate between what is known in temnospondylous amphibia and reptilia.

The same writer (16) in a discussion of the faunal relations of the early vertebrates, presented before Section E of the American Association in 1909, gives the relations of the American Permian and Carboniferous amphibian faunas with those known elsewhere. He reaches the conclusion that the Permian fauna is especially isolated. In his discussion of the Microsauria he says, "It has been assumed on entirely insufficient evidence that they too were all amphibians"—and later: "We may be assured that some of them before the close of the Pennsylvanian were inhabit-

ants of high-and-dry land regions where fleetness of movement, rather than obscurity, preserved them from their enemies, crawling reptiles in everything save some insignificant technical details of their palates." This has been recognized by many students of the fossil amphibia and Gadow placed them in a new group which he has called *Proreptilia*, but his classification does not seem to have been accepted. Dr. Williston says further, "Specialization of the microsaurians had reached the extraordinary extent of snake-like limbless forms." These snake-like forms have been usually associated in another order, the *Aistopoa*, but the reviewer has shown elsewhere that the group is a heterogeneous one and is made up of specialized microsaurian forms of diverse relationships.

Dr. E. C. Case (6) has described three, perhaps four, new forms of amphibia from the Permian of Texas. The forms as a whole are very insufficiently described. One species, *Trimerorhachis alleni* is described in ten lines and no figure given. This manner of descriptions should be subjected to the severest criticism as it imposes many heavy burdens on the shoulders of succeeding workers. The new genus *Tersomius* is not defined at all. While we may not doubt that the genus is new, judging from the single outline figure, yet it would have been much better, for those who are not so well acquainted with the Permian fauna as is Dr. Case, had he given in what ways it differs from the other amphibia. He allies the genus with *Trimerorhachis* at least so far as resemblances are concerned. The new genus and species are given in fifteen lines of less than ten words each.

A new form, *Gymnarthrus willoughbi*, is much better described. Its relations are uncertain. Dr. Broom allies it with the amphibia, but Dr. Case does not regard the form as such. He remarks its close alliance with *Cardiocephalus sternbergii*, which is amphibian. If *Gymnarthrus* is not amphibian it is certainly a very remarkable amphibian-like reptile.

Dr. E. B. Branson (7) has described and figured, in an excellent photograph, footprints of possible amphibians from the Mississippian rocks of Giles Co., Virginia. Five well-preserved tracks are represented in the figure. The author proposes the new specific name *Dromopus aduncus* and gives a list of the amphibian footprints known from the Mississippian.

The most notable attempt on the part of paleontologists, to elucidate an entire amphibian fauna, is that of Armand Thevenin (8) in the most important memoir on fossil amphibia for many months. The National Academy of France awarded him a prize

for the presentation of the memoir. The paper was published in successive issues of the *Annales de Paleontologie* and in complete form contains sixty-three quarto pages and nine photogravure plates, illustrating all that is known of the Paleozoic amphibian fauna of France up to the present.

The author divides the amphibian forms into four groups: the Phyllospondyles, which is a subordinate group of the "Stegocephales"; the Temnospondyles; the Aistopodes, and the Microsaurians, which unfortunately he ranks in with the reptiles, and describes under this heading a form which a few years ago he had concluded was a rhynchocephalian. Dr. Williston was more inclined to regard it as a Cotylosaurian. Whatever reptilian group it belongs to the reviewer is unable to say, but he is quite certain it is not a Microsaurian.

Dr. Thevenin discusses, under the heading, Phyllospondyles, the forms *Protriton fayoli* Thevenin, *P. petrolei* Gaudry, and *Pelosaurus laticeps* Credner. The second group consists of *Actinodon brevis*, *A. frossardi* and *Euchirosaurus rochei*. The Aistopodes are represented by a single new form which is unnamed. The specimen strikingly suggests the snake-like amphibians of Ohio and Ireland. There are no true representatives of the Microsauria known in France.

Our author discusses some general questions in regard to the amphibia, such as—"the relations of the Autun amphibia to those of other countries," "the homologies of the temnospondylous and the phyllospondylous vertebræ," "homologies of the elements of the pectoral girdle," "the ancestry of the Stegocephalia" and "the descendants of the Permian Stegocephalia."

Nothing new is added to our previous knowledge of the complex relations of the elements of the temnospondylous vertebra, which is one of the most vexed and most discussed questions in connection with the extinct amphibia. His homologies of the elements of the pectoral girdle are the ordinary interpretations. The ancestors of the Stegocephalia are possibly the crossopterygian fishes, although this is no new conclusion nor does our writer claim this. Perhaps the crossopterygians will do as well as anything. At least they will serve until we find what the *real* ancestors were.

In a discussion on "the descendants of the Permian Stegocephalia" he concludes that the branchiosaurian forms were the ancestors of the modern Urodeles and that the Temnospondylia gave rise to some of the reptiles, possibly some of the Cotylosauria. Our author, on a later page, gives the stratigraphic dis-

tribution of the amphibians and reptiles of the Permian of France. His final conclusion is that the diversity of the reptiles and amphibians shows that the groups had arisen long previously and the existence of similar forms in Europe and America would indicate some land connection of the two continents during the Permian.

Dr. Friedrich von Huene has redescribed the skull of *Dasyceps bucklandi* (Lloyd) (9) from the Permian of Kenilworth. This skull was previously studied by Huxley, but rather inadequately described. After a careful description of the elements of the skull Dr. Huene locates the form in the family Melosauridae, although the form has characters which are unusual for the other members of this group. He discusses the character and significance of the "facialgrube" or internasal opening, which has been described in another Permian form by Williston. Huene finds the same opening occurs in many living urodeles and lists nineteen species in which the opening has been described. He says that it has also been observed in certain members of the Permian Microsauria described by Fritsch from Bohemia. Its significance is possibly the same as in the living amphibia, that of receiving the glandula intermaxillaris. Since this gland in living land-dwelling amphibia secretes a sticky substance used in capturing insects, Dr. Huene suggests that perhaps *Dasyceps* also captured insects. This may, of course, have been possible, but to the reviewer it suggests a greater activity than could be expected of such a sluggish creature as *Dasyceps* undoubtedly was, since it would require many insects to feed an animal three or four feet long and it would be necessary to secure them in some quantity. Dr. Huene suggests that the insects "im Perm und Carbon sehr bedeutende Grössen erreichten"; such was undoubtedly the case with a few species, but the great majority of insects of the Carboniferous and Permian do not greatly exceed the modern insect fauna, so that Dr. Huene's argument on that score is not a good one. *Dasyceps* was probably a land animal and Dr. Huene thinks this is indicated by the presence of the internal opening which occurs only in the land-inhabiting forms among recent Amphibia. Perhaps the analogy may be carried so far.

Dr. R. Broom (10) compares the Permian amphibian fauna of North America and Europe and finds little similarity. He regards the American types as more highly developed. He divides the Permian amphibia of North America into four groups.

He discusses again the relationship of *Lysorophus* and in his discussion quotes the reviewer as saying what he did *not* say. The point of the reviewer's criticism of the reference of *Lysorophus* to the Urodela was *not* the presence of ribs nor yet the snake-like character which Dr. Broom explains in a very elementary way, but it was the *character* of the ribs. Their long, curved condition is unknown among other Caudata and the reviewer does not feel satisfied that *Lysorophus* is a Urodele even though limbs should be discovered.

Dr. Broom suggests for the newly described *Gymnarthrus* of Case an amphibian relationship. The dorsum of the skull shows characters, however, which apparently ally it with *Pariotichus*.

Dr. Broom's other essay (11) on practically the same subject matter gives the additional suggestion that the American and African amphibia are "two different modifications of the same earlier fauna."

Mr. Robert Dunlop (12) has given some interesting notes on Carboniferous and other Paleozoic amphibia of Scotland contained in the Kilmarnock Museum before they were destroyed by fire. His notes are accompanied and illustrated by two excellent half-tone plates of photographs of type specimens of *Loxomma*, *Pteroplax* and *Anthracosaurus*, all of which is very welcome information.

Jaekel (14) has proposed a new classification for the Chordata which he calls Vertebrata. He divides the "Stamm" into three subgroups Tetrapoda, Pisces and Tunicata, and makes no allowance for amphioxus. He proposes two new classes of "Tetrapoda," Hemispondyla and Microsauria with the ordinary classes Amphibia, Reptilia, Aves and Mammalia. The forms he groups in his new class Hemispondyla are the branchiosaurs and a new group which he calls Sclerocepholi. Dr. Jaekel has made several bad blunders in this classification. The first one is to separate the branchiosaurs from the Amphibia, to which they belong without the slightest shadow of a doubt. The next one is the alliance of *Amphibamus* to the Branchiosauridæ, to which it is not so closely allied as it is to the Cotylosauria. *Amphibamus* is far removed in structure from the Branchiosauridæ. His next error is the inclusion of *Acanthostoma* in the same group with the Branchiosauridæ. Their structures do not indicate relationships at all.

His class Microsauria is wholly untenable, as Dr. Williston well says (17). The group which we call Microsauria now will undoubtedly require revision and it looks as if it were going to get

it, but that the animals now included in that group represent a class distinct from all other vertebrates I, for one, will not for a moment concede.

The fundamental error made by Dr. Jaekel, as the reviewer sees it, is the attempt to base a classification of vertebrates on a single character. This has always failed in the the past and must, in the nature of the case, fail in the future; since classification, if it is to mean anything, must take into consideration the entire organization. The paper is full of many other smaller errors, errors of knowledge and errors of judgment. One of these errors is relating such widely distinct forms as *Ceraterpeton* and *Diplocaulus*.

The same author has given a study of the limbs of the oldest vertebrates in which (15) he attempts to sustain his classification, but his facts and arguments are not at all convincing and the paper is little more than a republication of parts of the essays of other investigators.

Dr. Williston (17) has recently published another essay on the Permian fauna of Texas in which he gives especially a study of the vertebræ and adopts the view of Cope as to the ultimate fate of the elements of the rhachitinous vertebra. He regards *Eosauravus copei* Will. (*Eosauravus punctulatus* (Cope)) as allied to *Hylonomus* and for that reason "the oldest known reptile" is a microsauro. Just what his reasons for this alliance are he does not say. In the present imperfect state of our knowledge of *Hylonomus* and its Canadian brothers such a reference would be very uncertain. In the last paragraph he records the interesting discovery of limbs in *Lysorophus*.

A general review of the above essays shows that more than half of them represent pioneer work, that is, descriptive and classificatory investigations. Five of the essays bear more largely on the faunal relations as exhibited by the Amphibia. One gives us new light on the significance of a structure found in the ancient forms. This is where work is greatly needed. Our knowledge of the ancient amphibian fauna will increase as time goes on but the greater part of the pioneer work is already done. The way is now open for some good investigations on the structure of the ancient Amphibia and the meaning of these characters as interpreted in the light of modern comparative anatomy and embryology.

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